

A composite image showing the International Space Station (ISS) in the upper left corner, with its solar panel arrays extending across the frame. The background is a view of Earth from space, featuring a prominent green aurora (Northern Lights) that stretches across the horizon. The Earth's surface shows dark landmasses and lighter oceanic areas. The overall scene is set against the blackness of space.

ISS FPMU and DMSP SSIES Ne, Te Data

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ISS FPMU, DMSP SSIES, AFRL HASDM Data

ISS /Floating Potential Measurement Unit (FPMU)

~400 km altitude circular, 51.6 deg inclination

Ne, Te, Vfloat: 1 second Vfloat: 1/128 second

- ISS Program operates the FPMU suite of plasma instruments with a primary goal of supporting engineering activities
- FPMU electron density (Ne) and temperature (Te) is also useful for scientific studies of the F2-ionosphere

DMSP/Special Sensor for Ions, Electrons, and Scintillation (SSIES)

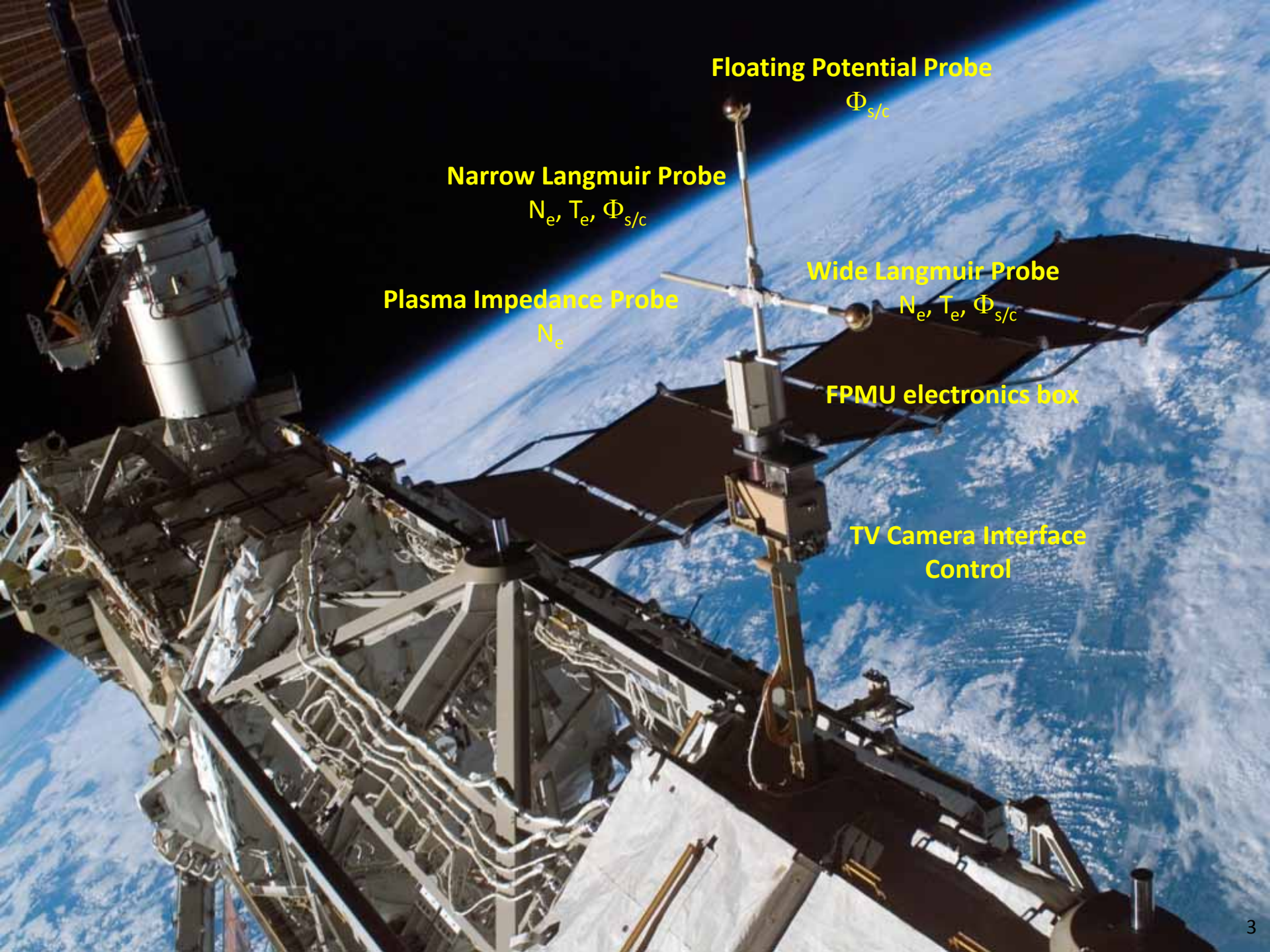
~850 km altitude circular, 98 deg inclination

Ne, Te, Vfloat: 4 second

- DMSP SSIES data from topside ionosphere is distributed by NOAA National Geophysical Data Center. MSFC maintains a full set of this data and can provide DMSP Ne, Te records corresponding to periods with ISS FPMU data

AFRL HASDM neutral mass density

- AFRL can provide High Accuracy Satellite Drag Model neutral mass density along both ISS and DMSP orbits for periods where Ne, Te data is available



Floating Potential Probe

$$\Phi_{s/c}$$

Narrow Langmuir Probe

$$N_e, T_e, \Phi_{s/c}$$

Plasma Impedance Probe

$$N_e$$

Wide Langmuir Probe

$$N_e, T_e, \Phi_{s/c}$$

FPMU electronics box

**TV Camera Interface
Control**

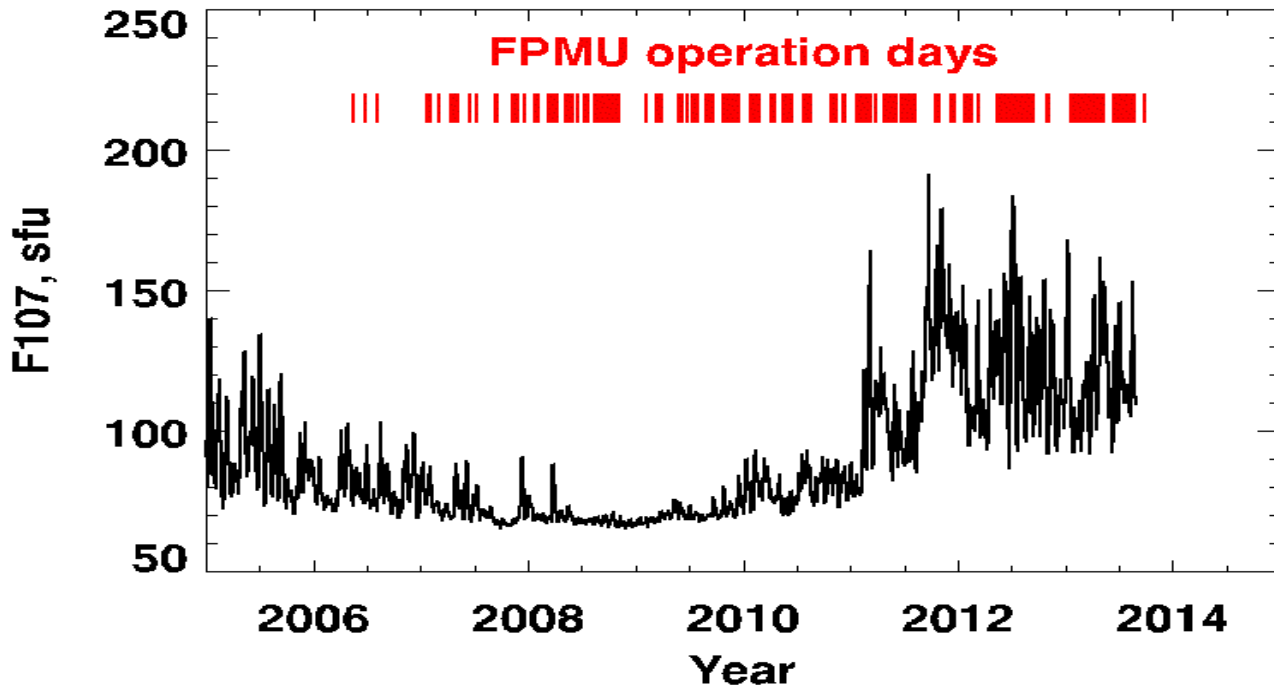


ISS FPMU Operations

- FPMU data is encoded into a video signal and transmitted in ISS Ku band telemetry stream, live signal is required to acquire data by ground stations
 - Ku band telemetry is a resource shared between ISS operations and science activities
 - Amount of time the TVCIC video box can be operated is restricted
 - FPMU operated on a campaign basis < ~30% of a year for periods of ~days to ~weeks
- Scheduled operations support ISS engineering and science activities:
 - Characterizing ISS 160 V solar array interactions with ionosphere plasma
 - ISS charging due to visiting vehicles
 - US and Russian extravehicular activity (EVA) support
 - ISS science payload support
 - Collaborative ionospheric research with other spacecraft and ground based facilities
 - Incoherent Scatter Radar World Day periods
- Unscheduled (short term response) operations:
 - Anomaly investigations
 - Targets of opportunity for collaborating with ISS science payloads, instruments on independent spacecraft, or ground base science operations
 - ISS auroral charging
 - Ionospheric response to geomagnetic storms



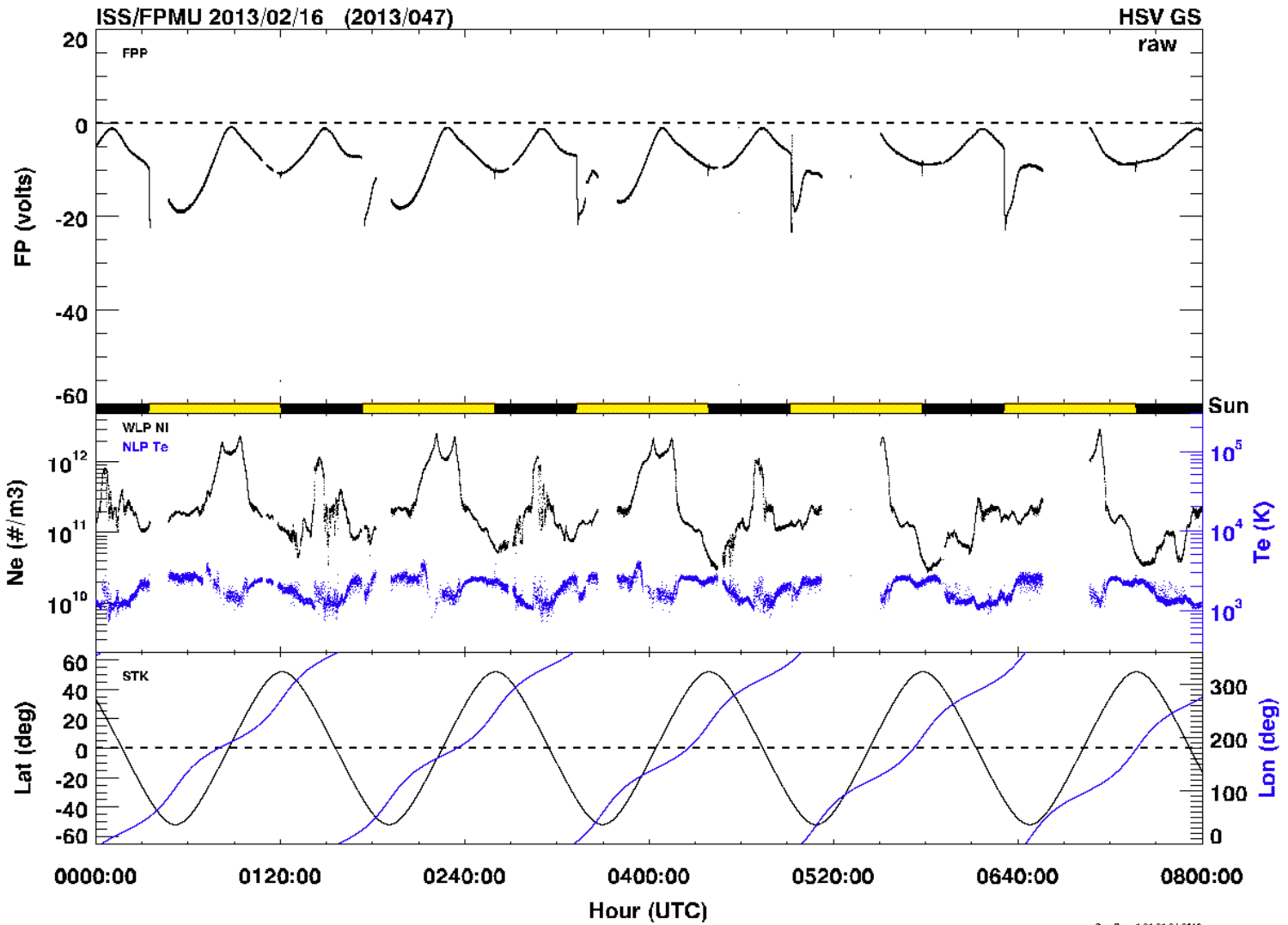
FPMU Operations Summary



YEAR	Operation Days
2006	8
2007	39
2008	105
2009	102
2010	95
2011	136
2012	94
2013	130*
Total	709*

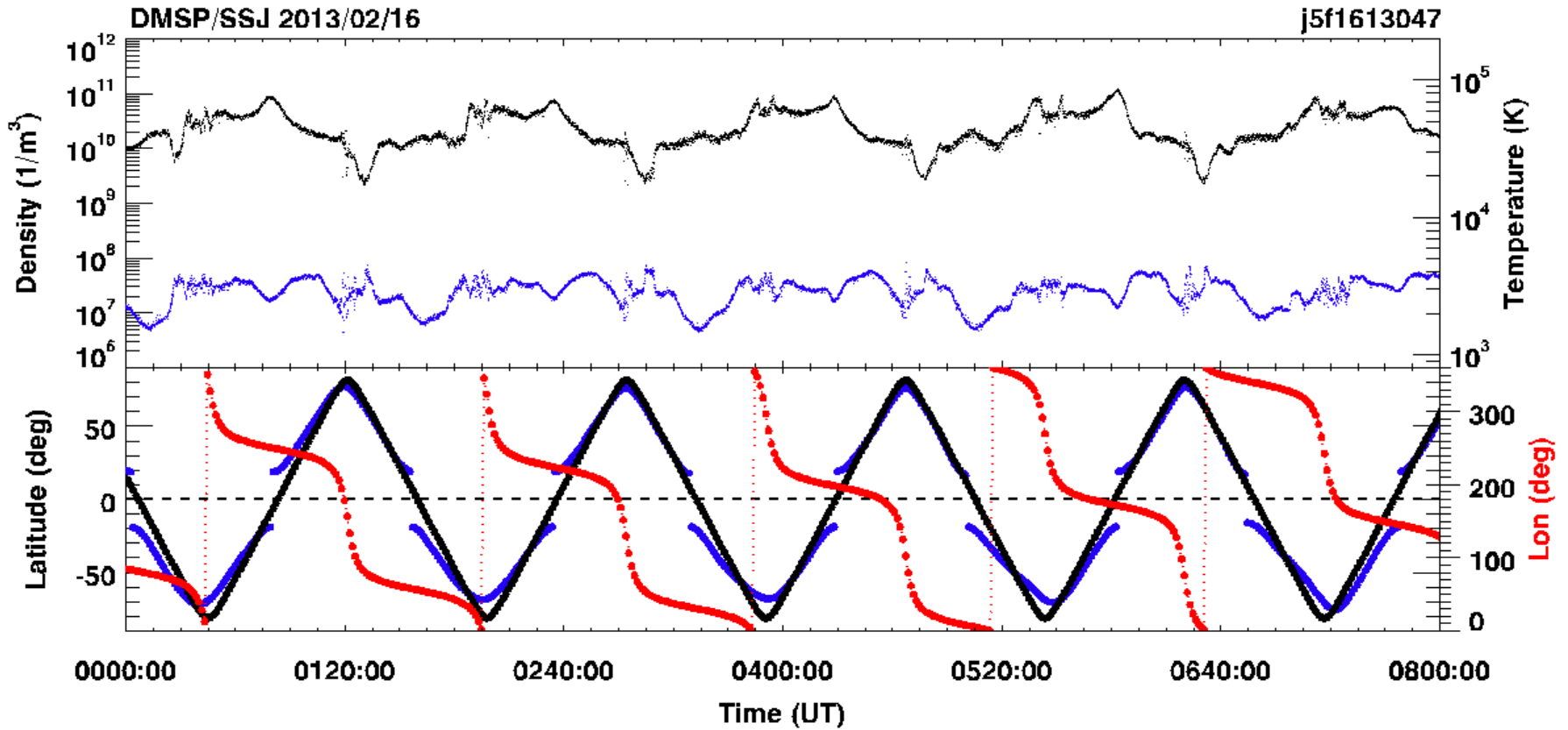
*6 Aug 2006 to 1 Nov 2013

YEAR	Max Kp	Min Dst	Max F107
2006	5.7	-48	81.2
2007	5.3	-59	88.8
2008	6.3	-86	88.2
2009	5.7	-83	80.4
2010	7.7	-81	93.1
2011	7.7	-132	166.3
2012	8.0	-143	171.4
2013	6.7	-132	153.5



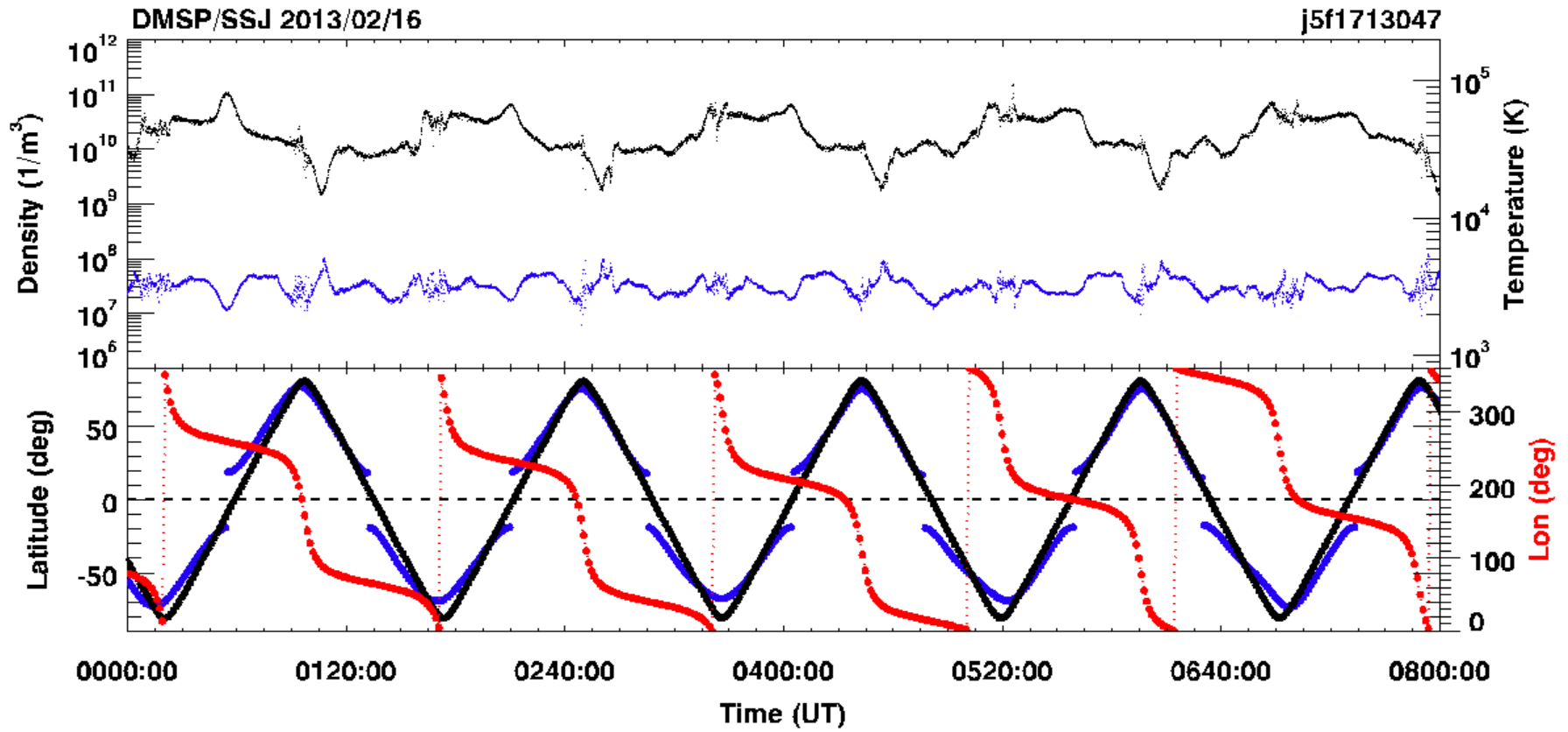


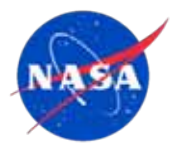
DMSP F16 16 Feb 2013



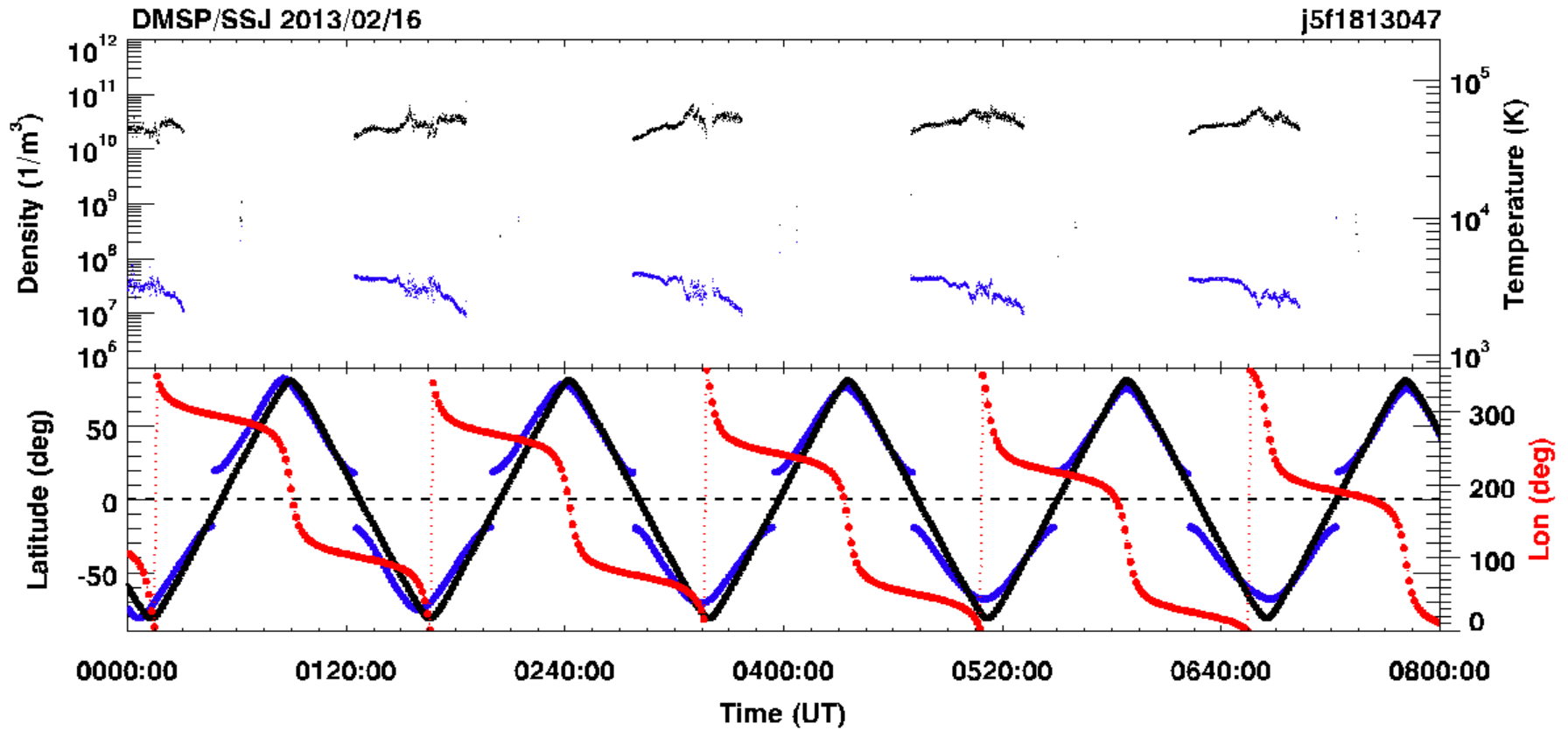


DMSP F17 16 Feb 2013





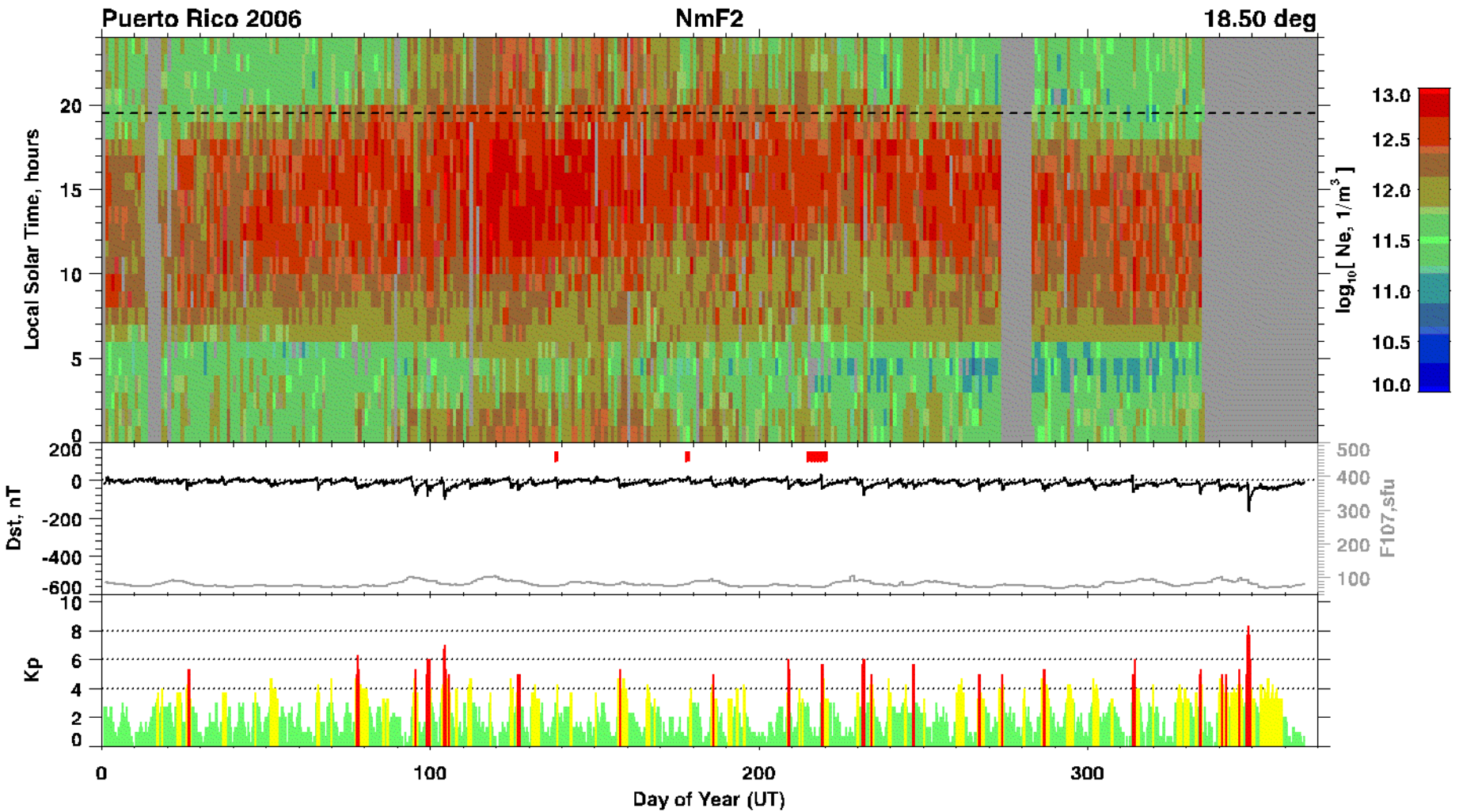
DMSP F18 16 Feb 2013





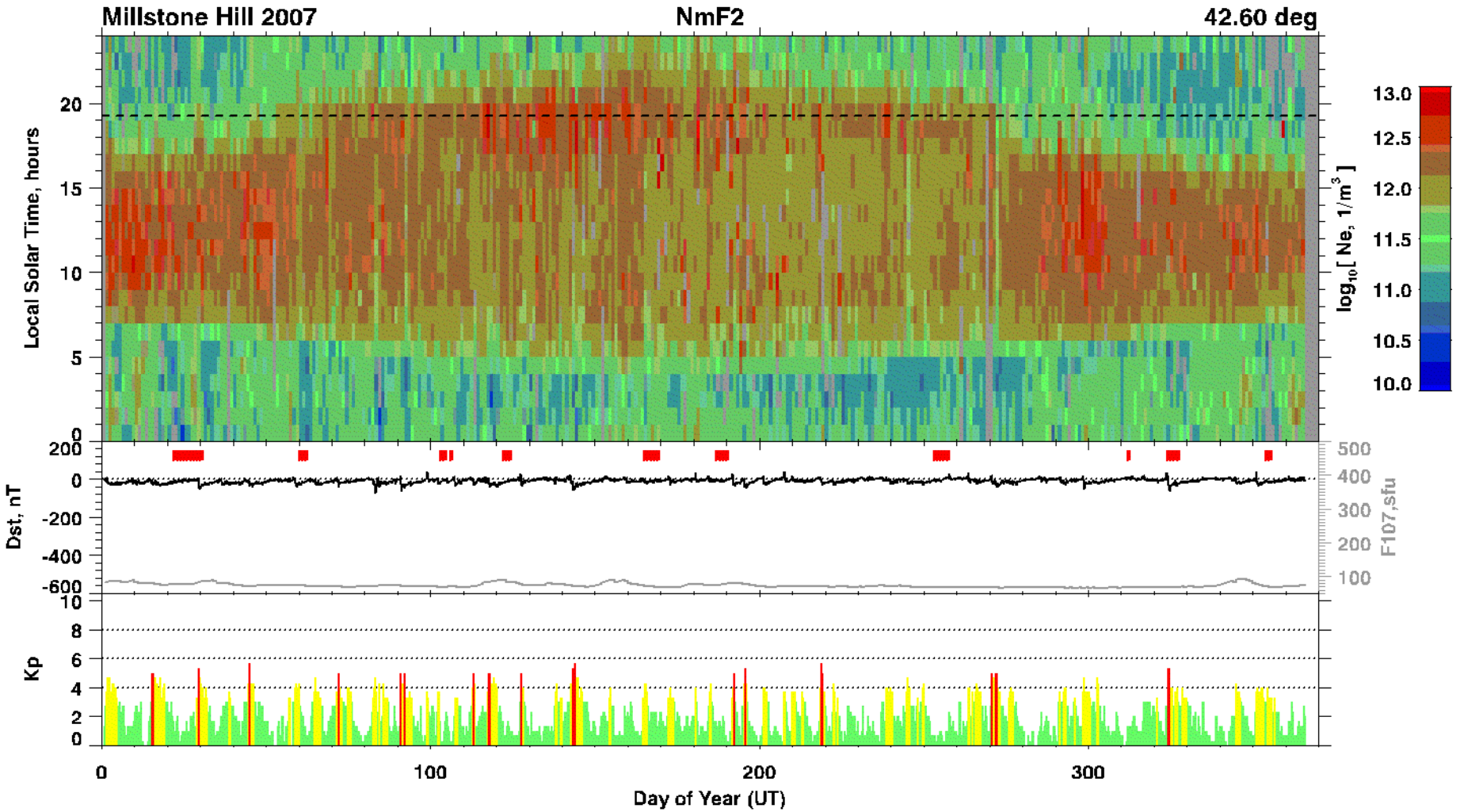
2006

FPMU operation periods marked with red bars above Dst



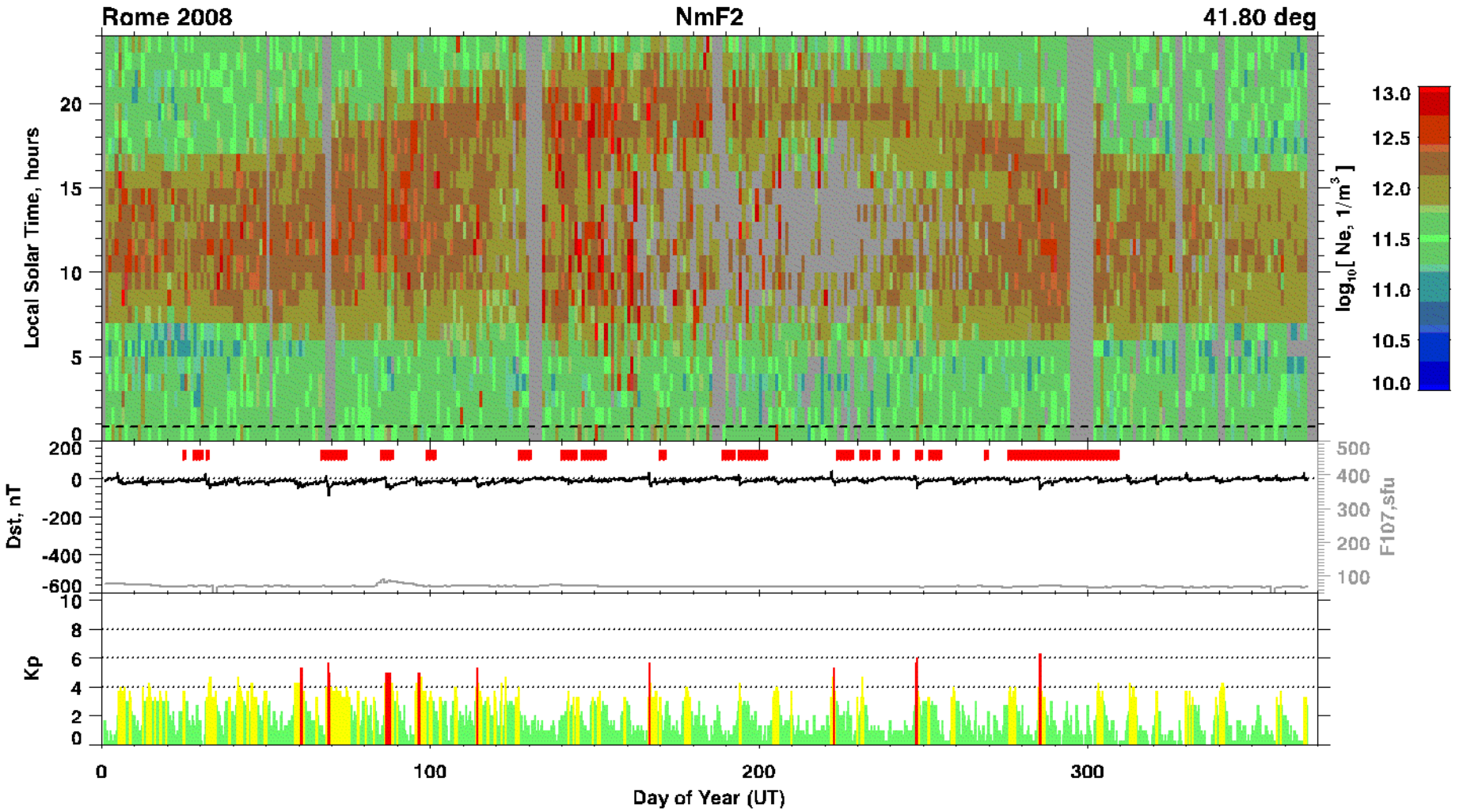


2007



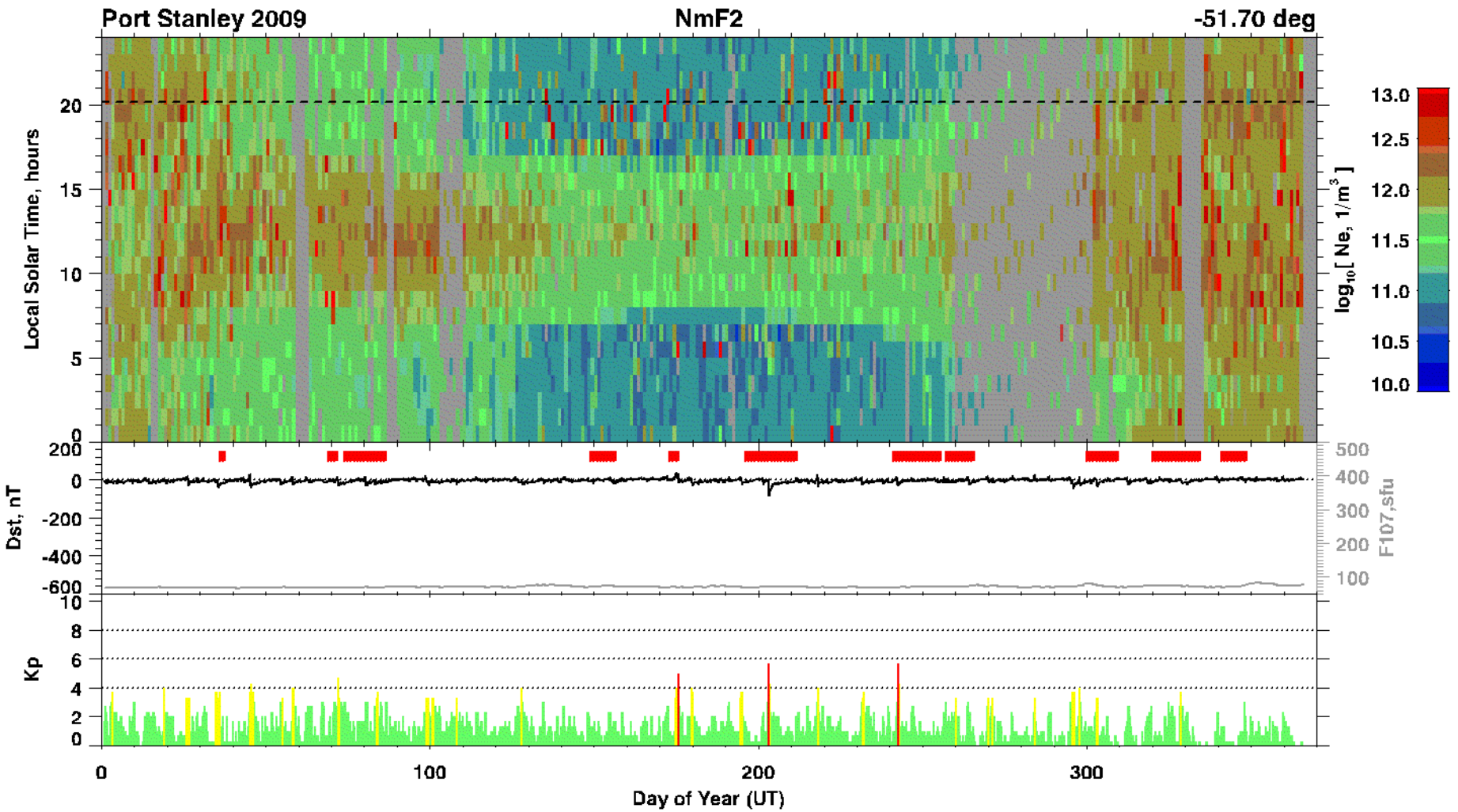


2008



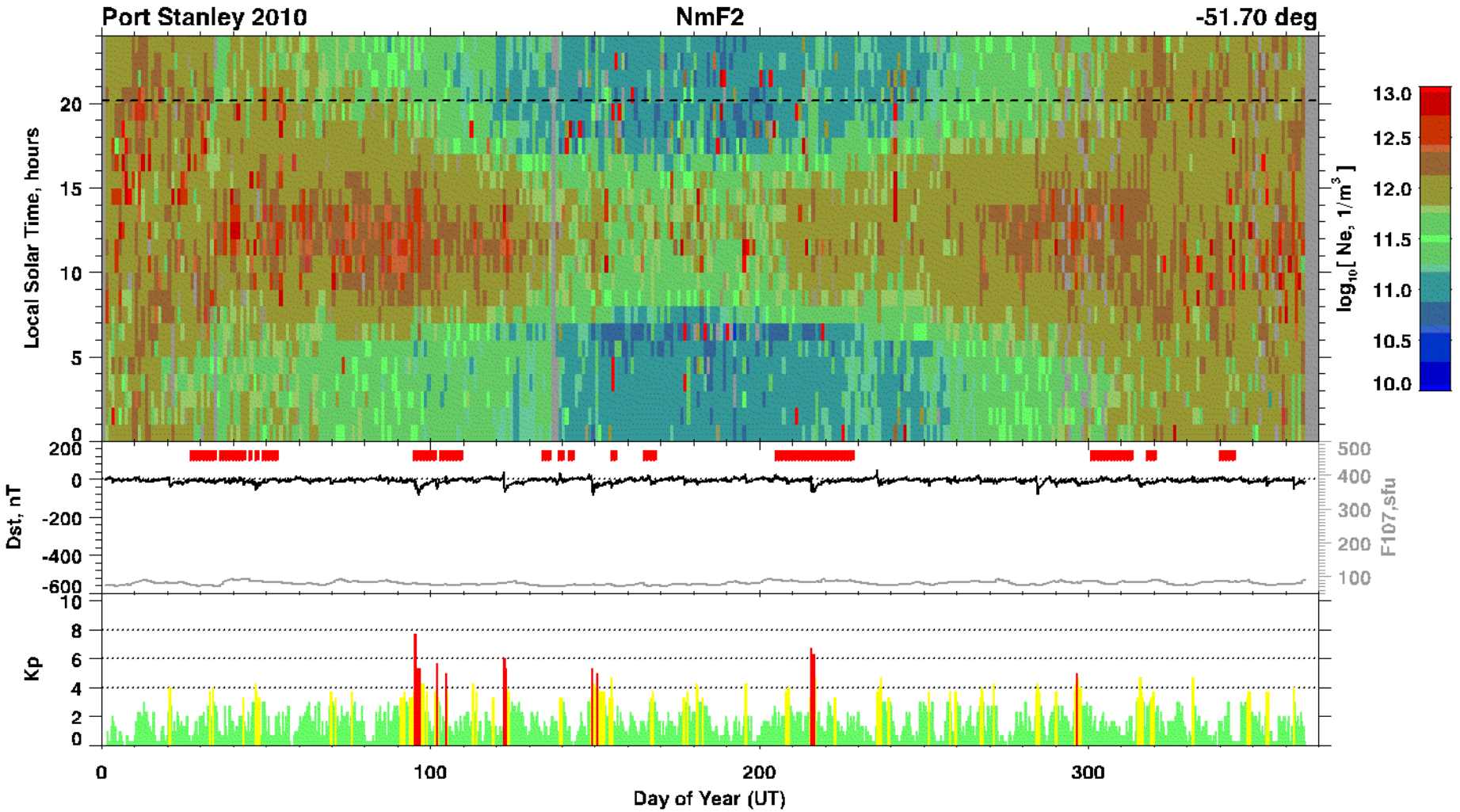


2009



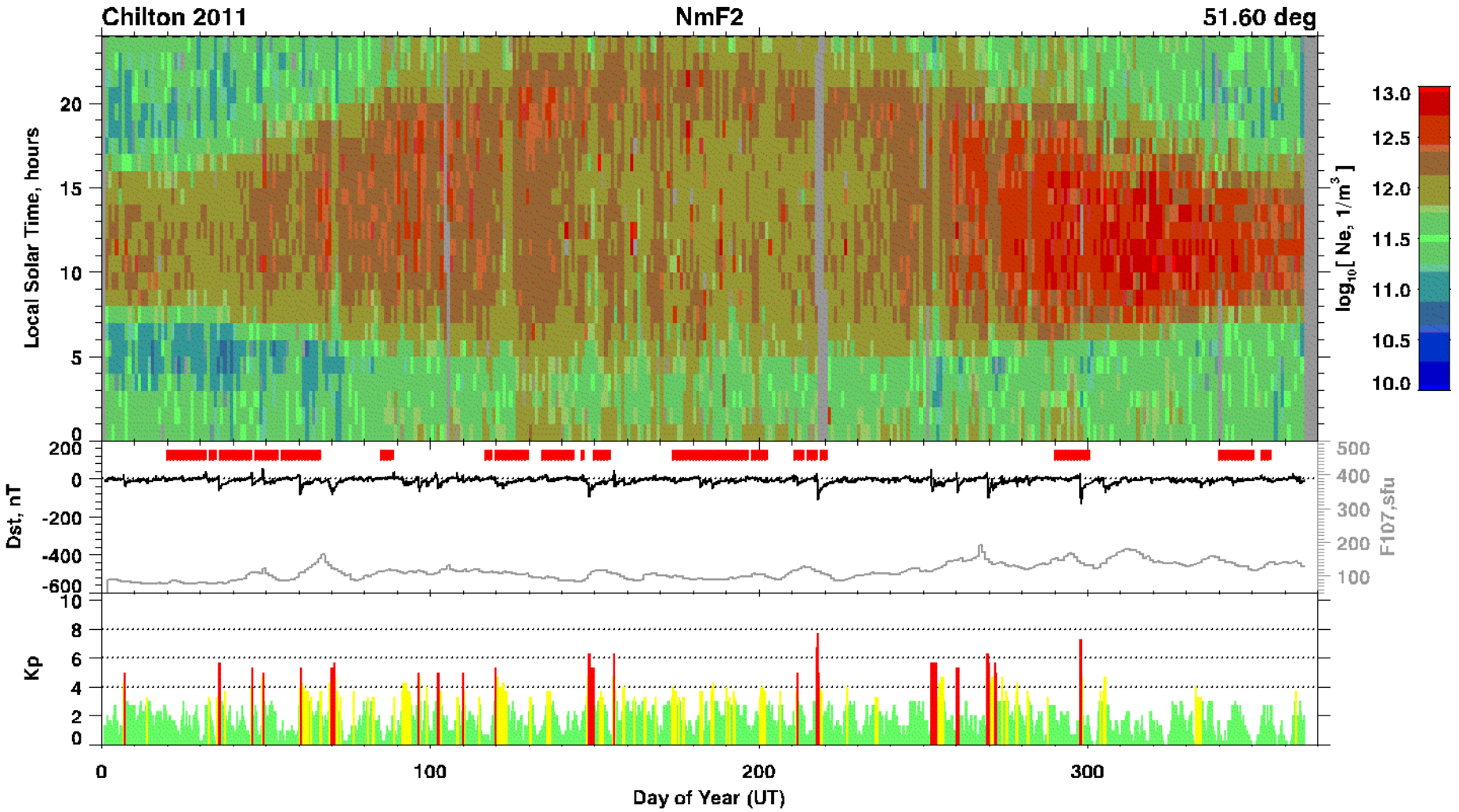


2010



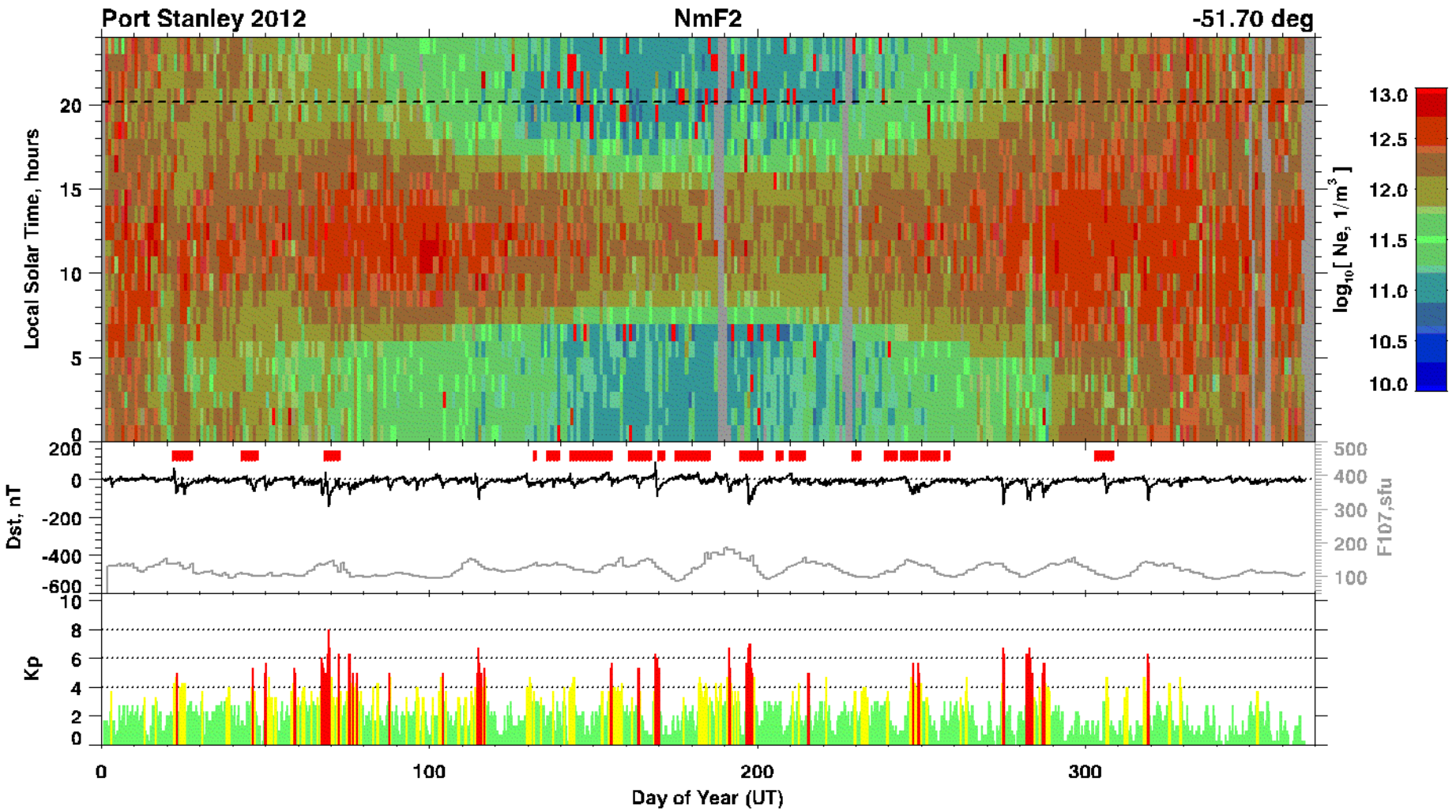


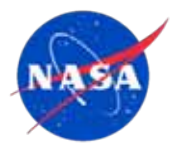
2011



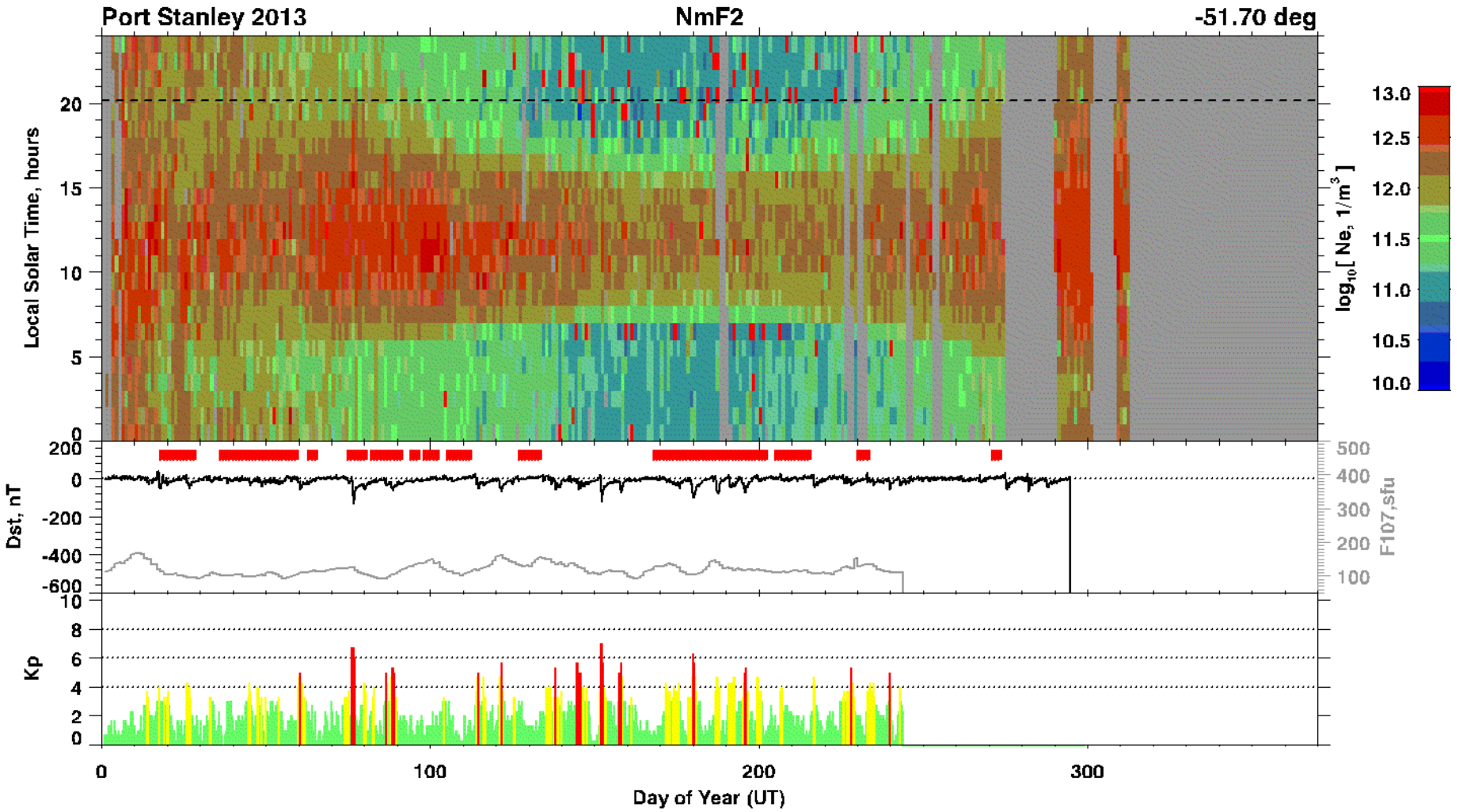


2012





2013





MSFC Interests in FPMU, DMSP Data

Characterizing ISS frame potential variations due to:

- ISS photovoltaic power system (US 160 V, RS 28 V) interactions with plasma environment
- Visiting vehicles
- Payloads
- Space weather effects

Auroral charging of ISS

- Maximum ISS auroral charging to date is ~ -17 V above background, why?
- Are the ~ -1 to ~ -2 kV potentials observed by DMSP possible for ISS?
- What geophysical conditions will result in extreme charging for ISS
- Can nominal, extreme ISS auroral charging conditions be predicted?



Periods with ISS Auroral Charging

ISS Auroral Charging Observations

FPMU Operations

26 March 2008 (GMT 086)

5-6 April 2010 (GMT 095-096)

22,23,25 January 2012 (GMT 025)

9-11 March 2012 (GMT 069-071)

23 May 2012 (GMT 144)

15-16 July 2012 (GMT 197-198)

3 September 2012 (GMT 247)

20 January 2013 (GMT 020)

17 March 2013 (GMT 076)

28,29 June 2013 (GMT 179,180)

STS-123/ESA ATV-001 docking

STS-131/19A

SWx: M8.7 flare, CME ~2211 km/s

SWx: X5.4 flare, CME ~2200 km/s

X1.3 flare, CME ~1800 km/s

SpaceX Dragon berth/unberth

SWx: X1.4 flare, CME ~1400 km/s

US EVA 19

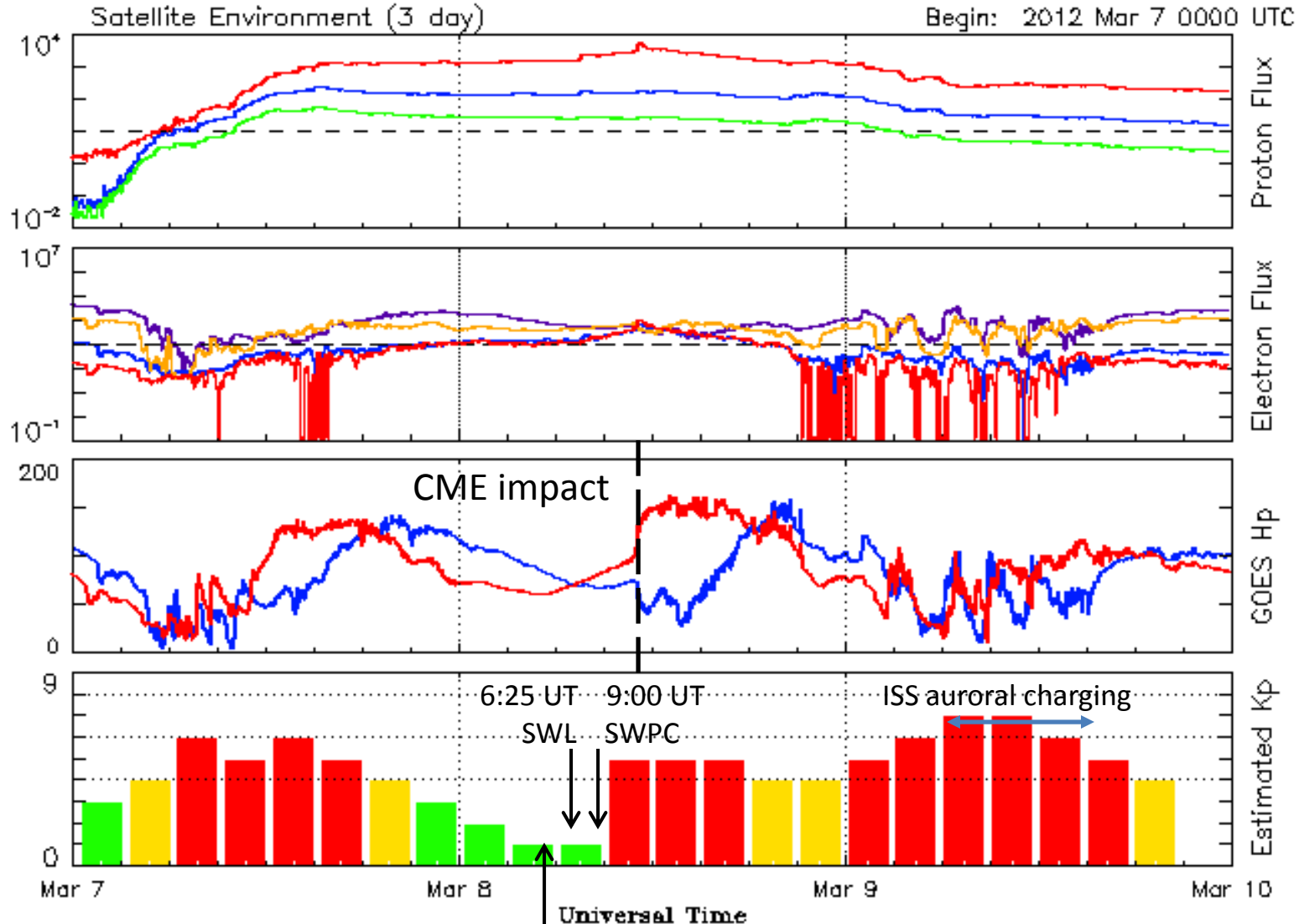
Solar Cycle 24 Solar Maximum Conditions

SWx: M1.1 flare, CME ~1400 km/s

US EVA 22,23



March 2012 Geomagnetic Storm



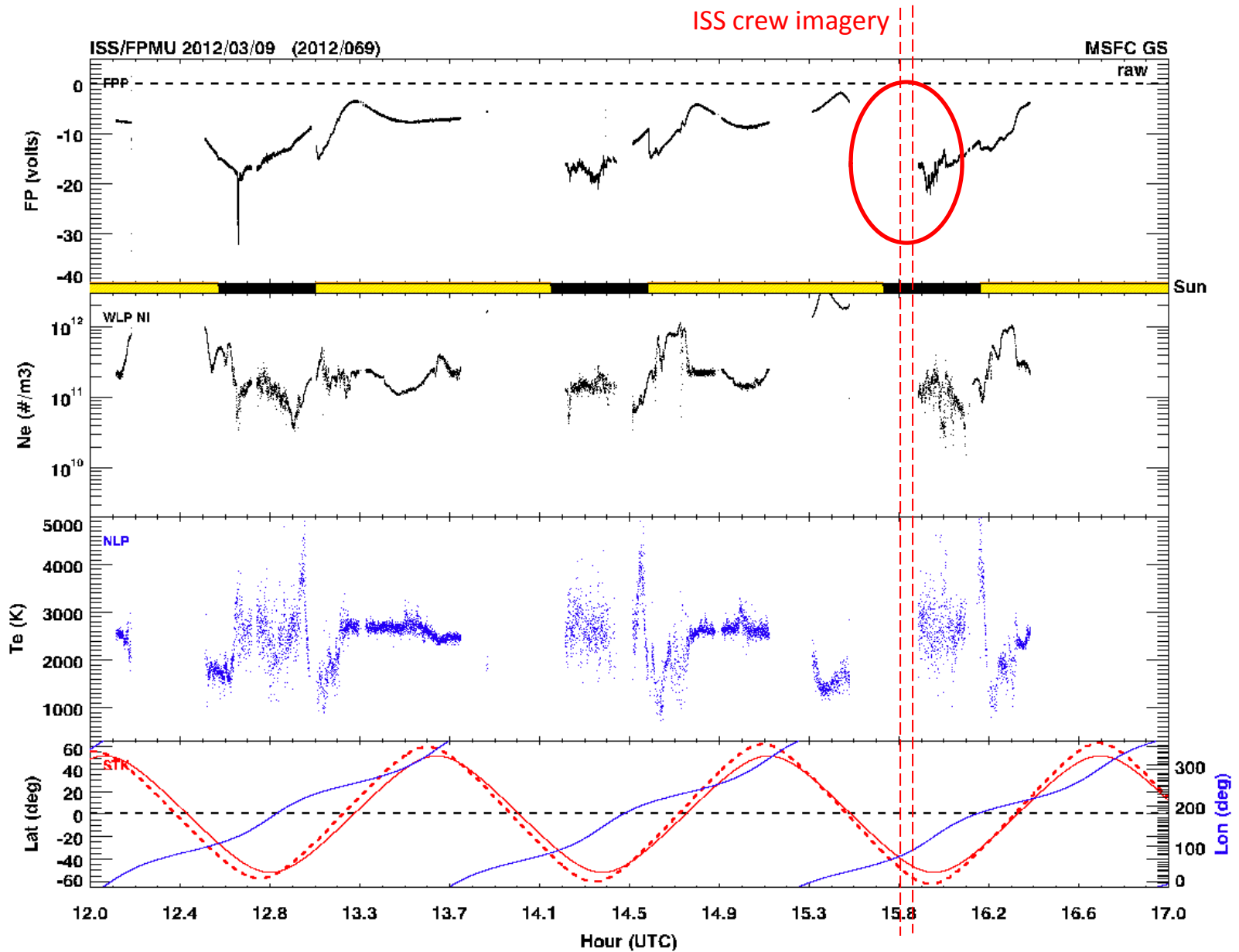
Updated 2012 Mar 9 23:56:06 UTC

NDAAs/SWPC Boulder, CO USA

FPMU activated based on CME alerts

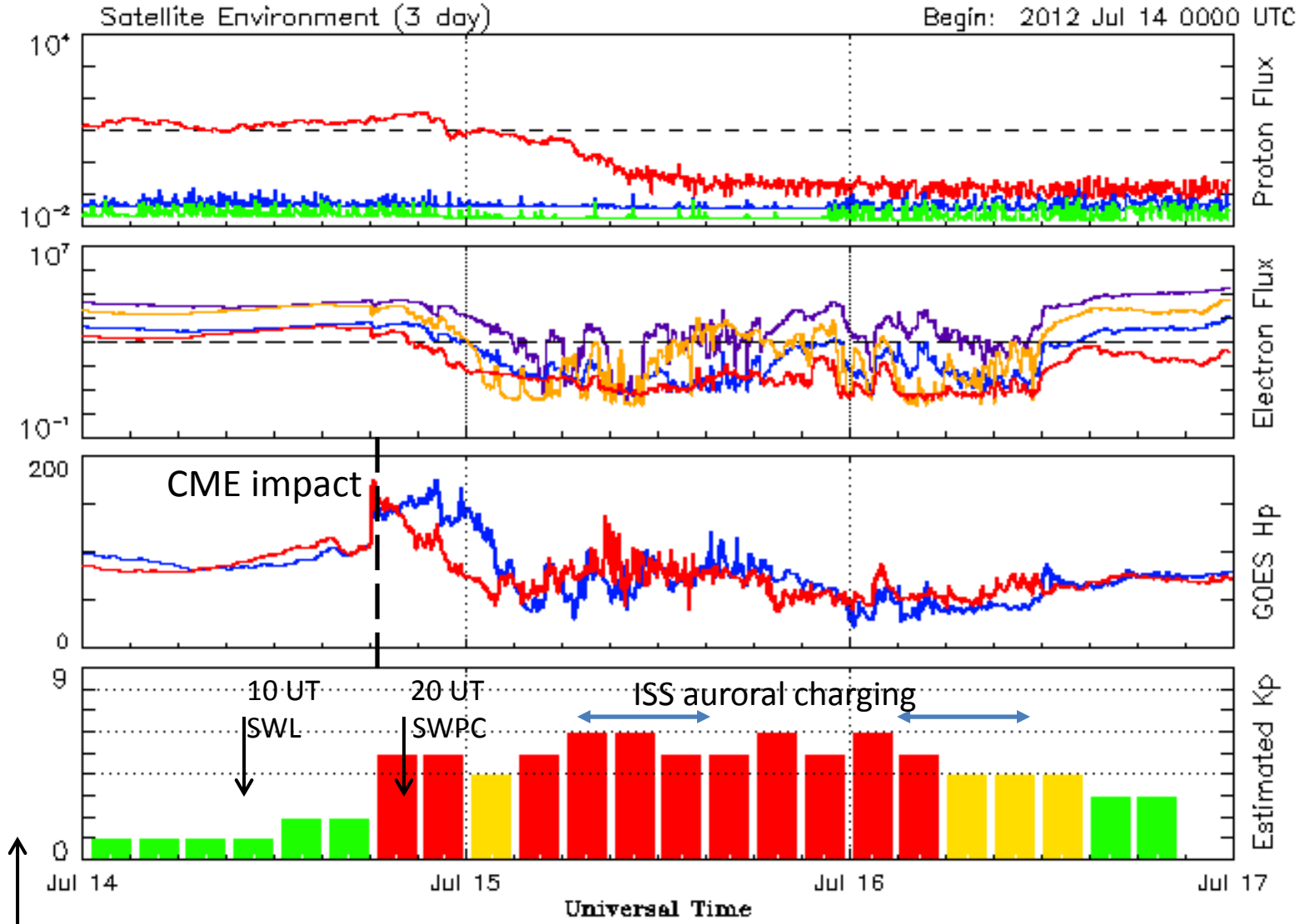


9 March 2012





July 2012 Geomagnetic Storm



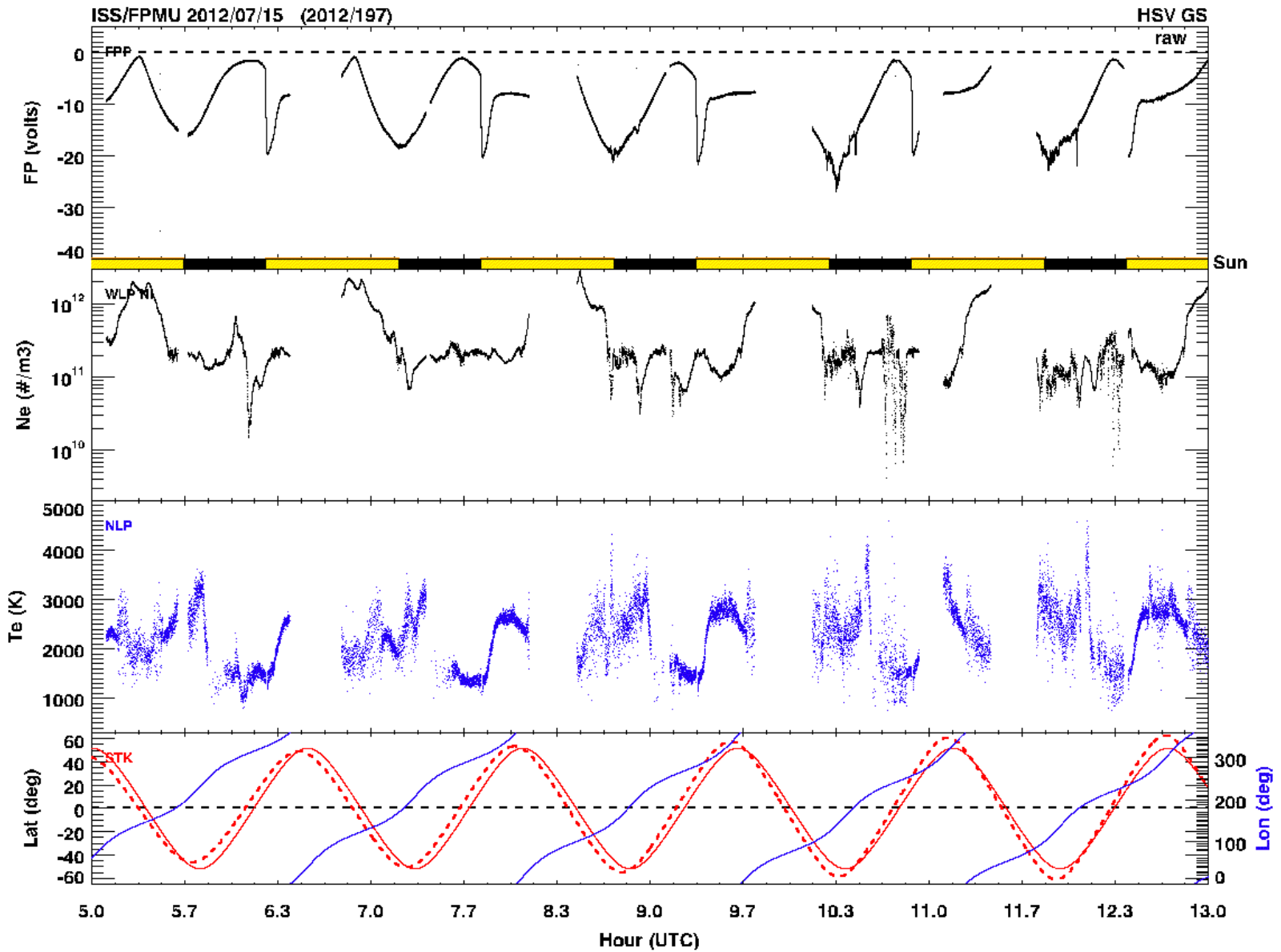
Updated 2012 Jul 16 23:56:05 UTC

NDAAs/SWPC Boulder, CO USA

FPMU activated 13 July based on CME alerts



15 July 2012





Questions?